
PAUL VALLONE

Wet weather has turned this feedlot into deep mud.

Low-Cost Way To Pave Feedlots

"Flyash" could become the latest buzzword around the barnyard.

Thanks in part to studies by Agricultural Research Service and industry scientists, this powdery byproduct of burning coal to generate electricity is now helping dairy farmers mud-proof their barnyard feedlots. That's where heavy winter or spring rains quickly turn soils to knee-deep mud, bogging down hefty cows, subjecting them to disease, and sapping them of energy to produce milk.

But research has shown that by paving feedlot areas with a hydrated form of flyash, farmers can build a solid foundation to give their cows a leg up on mud. Not only is flyash cheaper than paving with concrete—$6 per square yard versus $75—it poses little danger to the environment.

That's the verdict from pilot studies conducted by ARS soil scientist William L. Stout in cooperation with professional geologist Thomas L. Nickeson of Wellsboro, Pennsylvania, and two commercial partners—Gerry Thompson of Air Products and Chemicals (AP&C), an Allentown, Pennsylvania, company; and Paul Cunningham of Black Rivers Co-Gen Partners, a Fort Drum, New York, power plant.

One study, conducted in 1995-96 on an experimental dairy farm north of Harrisburg, Pennsylvania—and funded by the U.S. Department of Energy—examined the environmental impact of spreading 33 tons of flyash onto a 900-square-foot feedlot. Researchers applied a form of flyash gleaned from a coal-burning process called fluidized-bed combustion that is employed by the electric utility industry.

Using instruments called suction lysimeters, the team monitored the concentrations of various elements and heavy metals seeping into groundwater from the flyash pads. Later, they compared the data with that collected from an unpaved feedlot, says Stout, who is at ARS' Pasture Systems and Watershed Management Research Laboratory in University Park, Pennsylvania.

Though lab analysis revealed minute traces of elements like calcium and nickel, a heavy metal, "we weren't able to

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Cattle have a firm footing in this barnyard lot paved with ash produced at the Fort Drum (New York) Cogeneration Facility.

detect anything at unacceptable levels," says Stout, referring to threshold levels for safe drinking water set by the U.S. Environmental Protection Agency.

Based on results from the Harrisburg study and other earlier ARS projects, the New York Department of Environmental Conservation subsequently approved farmer use of flyash as a safe barnyard paving resource. Follow-up studies conducted by Nickeson and collaborators at AP&C and three other companies also expedited approval in parts of El Niño-soaked California.

Mike Huggins, of the San Joaquin County Environmental Heath Division, said five dairy operations in his jurisdiction have paved their lots with a local plant's flyash to protect their cattle from high water and muddy conditions that promote disease.

"Right now, we have the University of California-Davis Medical Veterinary School looking at flyash from an animal health standpoint," says Huggins. Evidence collected from the farms thus far points to a sharp drop in cases of hairy footwort, a viral hoof infection, and mastitis, a bacterial udder disease.

For Nickeson, using flyash to pave feedlots is a win-win situation for both the electric utility industry and dairy producers. By selling the flyash, power plants save money on waste disposal; by using it, farmers safeguard their cattle's welfare and ensure peak milk production and growth during the rainy season.

Paving also helps direct manure towards waste utilization systems, says Stout. That helps reduce the potential for nitrogen and phosphorus to contaminate groundwater.—By **Jan Suszkiw**, ARS.

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"Star Wars" Technology May Solve Down-to-Earth Insect Problem

Research is often like the rising tide that lifts all boats: One scientist's discoveries sometimes help colleagues in a completely unrelated field. That's how ARS entomologist Guy J. Hallman found himself controlling insects with electrical pulses.

At ARS' Crop Quality and Fruit Insect Research Unit in Weslaco, Texas, Hallman studies ways to prevent insect pests from hitchhiking on exported citrus. New methods for certifying U.S. citrus as pest free are needed before a U.S. Environmental Protection Agency ban on the fumigant methyl bromide takes effect in 2005.

Methyl bromide is currently the workhorse of fumigants used on a variety of crops in postharvest processing. But its days are numbered because it may deplete the Earth's ozone layer.

While scanning the scientific literature one day, a technical report by Q. Howard Zhang grabbed Hallman's attention. Zhang, a food processing engineer at Ohio State University, had used pulsed electric fields (PEF) to inactivate microbes such as *Escherichia coli* in food. "I imagined PEF technology might also kill fruit fly eggs and larvae in citrus," Hallman said.

PEF releases microsecond bursts of high-voltage electrical current. Unlike continuous current, PEF generates only a tiny amount of heat. Applied to certain foods, the process, called cold pasteurization, avoids changes in color, flavor, texture, and nutrients that might occur with thermal pasteurization.

Zhang himself had earlier been given a boost by researchers in a completely unrelated field—space.

In a lucky find, the Ohio State researcher uncovered an electrical pulse generator while exploring outmoded equipment shelved by the National Aeronautic and Space Administration. Researchers working on the Strategic Defense ("Star Wars") Initiative had used the generator to test communications microwave tubes.

After reading Zhang's report, Hallman suspected that, since insects are more complex than bacteria, PEF could destroy citrus pests with less than the 25,000 volts needed to kill *E. coli*. Hallman contacted Zhang, and the two began collaborating on trials using PEF to control a dangerous citrus pest—the Mexican fruit fly.

The researchers exposed fly eggs to ten 50-microsecond pulses of about 9,000 volts. Each pulse lasted for only 1- 20,000th of a second, but that was enough—less than 3 percent of the eggs hatched. Of the few that hatched and became larvae, none survived to adulthood.

Larvae proved even more vulnerable to PEF. None treated with as little as 2,000 volts lived past the pupal stage to adulthood. "Judging from the larvae's inability to recover from general paralysis," Hallman says, "we think PEF is very damaging to their nervous systems."

Is PEF an immediate candidate to replace methyl bromide? Hallman says it's not.

"A great deal more research is needed before we use PEF as a quarantine treatment." To that end, ARS is seeking an industrial partner to explore the potential for treating citrus with PEF.

Equipment limitations have thus far prevented the researchers from assessing PEF's effect on fruit quality. Future studies must also determine the economic feasibility and efficacy of PEF before the procedure could be approved for citrus certification.

Still, Hallman says, "It's imperative we examine a host of novel approaches that may come from work completely unrelated to insect control. No single method will completely replace methyl bromide."—By **Ben Hardin,** ARS.

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